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(54) **SUSPENSION APPARATUS OF WASHING MACHINE**

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(52) **U.S. Cl.** **68/23.3**; 68/23.1; 68/23.2
(58) **Field of Search** 68/23.3, 23.1, 68/23.2

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Primary Examiner—Frankie L. Stinson

(57) **ABSTRACT**

A suspension apparatus of a washing machine which supports a washing tub in a suspended state in a casing of the washing machine is disclosed. The suspension apparatus includes suspension rods supporting the washing tub in the casing in a suspended state, damper bases installed at the lower ends of the suspension rods, damping force changing members fitted around the suspension rods so as to be compressed according to the variations in load of the washing tub and change the damping force, and elastic members installed between the damping force changing members and the damper bases. Since the damping force of the suspension apparatus is changed according to a washing load generated by the washing tub during the operation of the washing machine, vibrations and noises of the washing tub can be minimized.

6 Claims, 9 Drawing Sheets

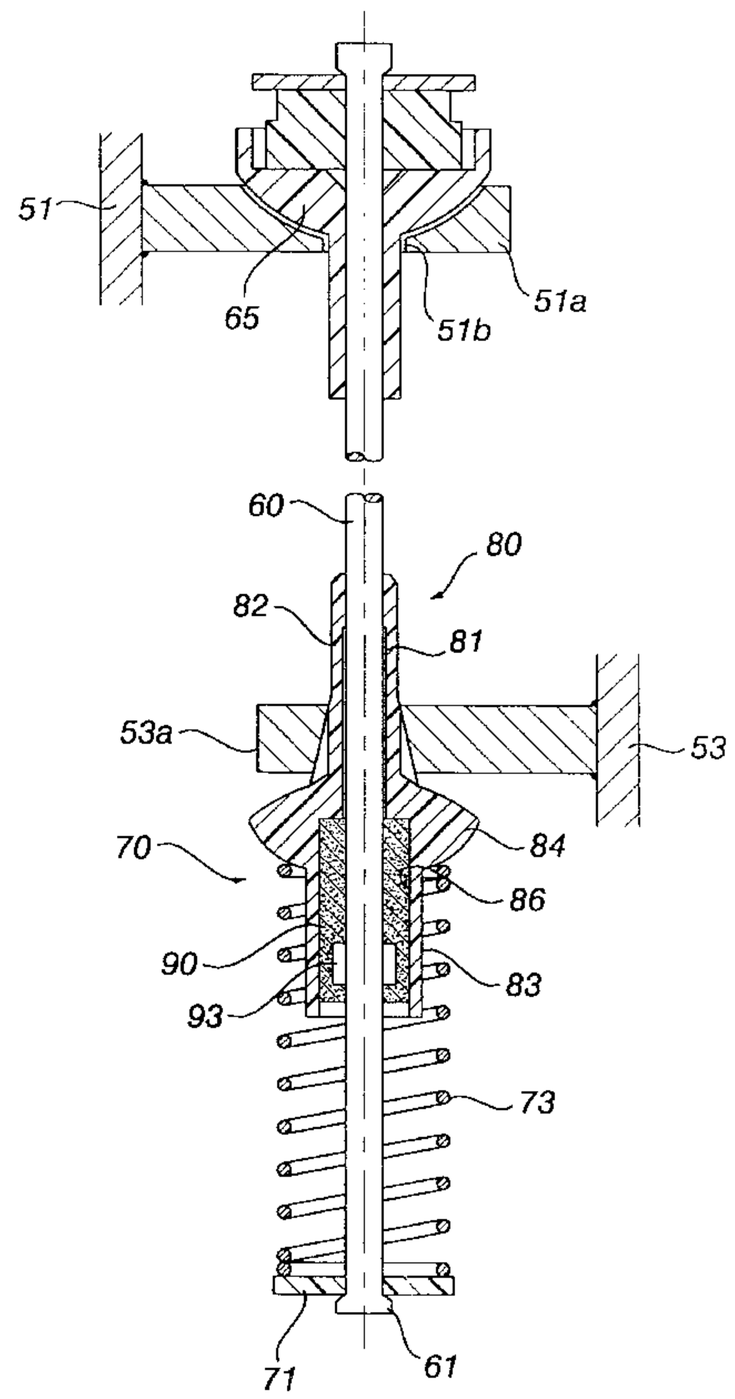


FIG. 1 (Prior Art)

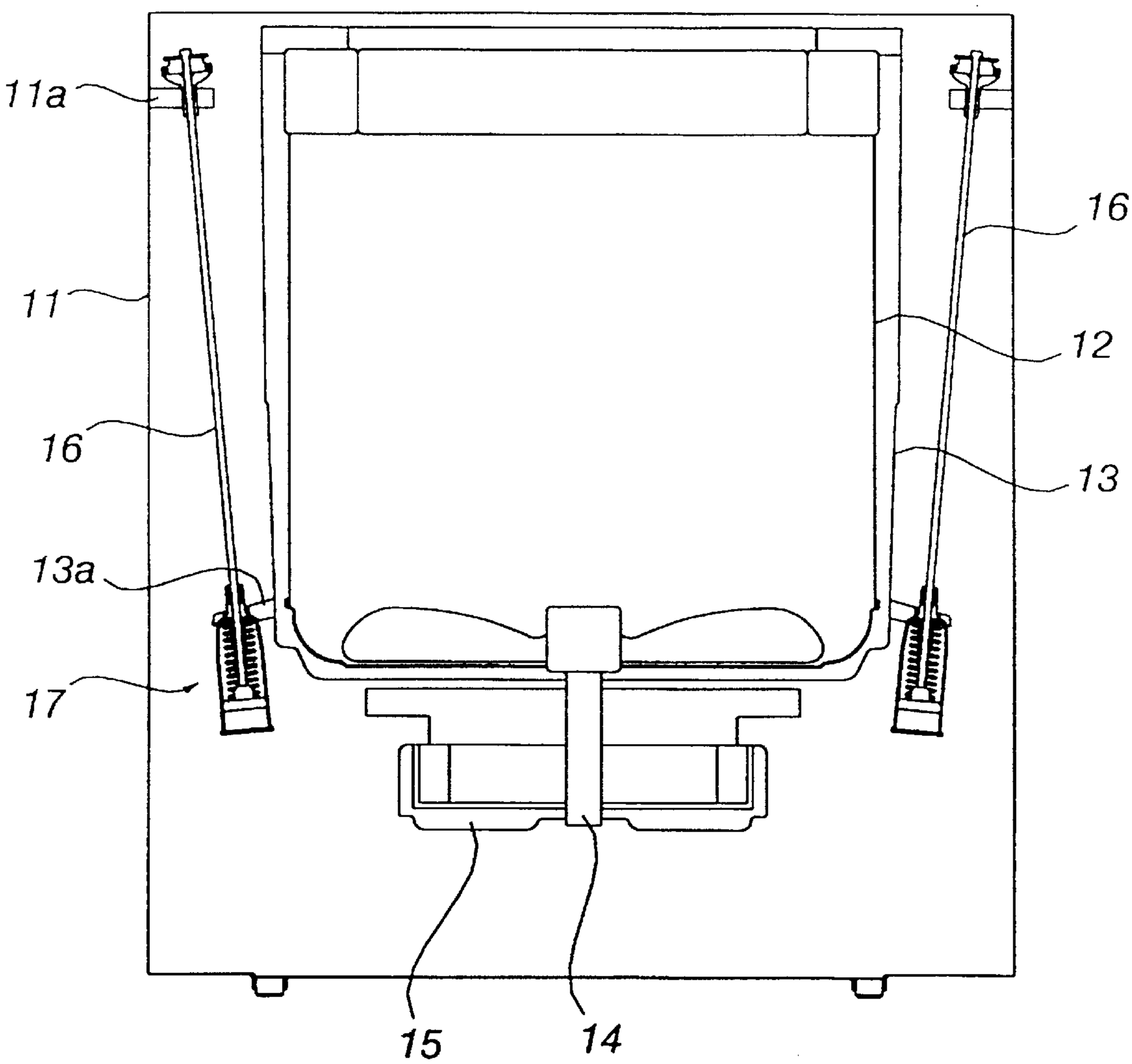


FIG.2(Prior Art)

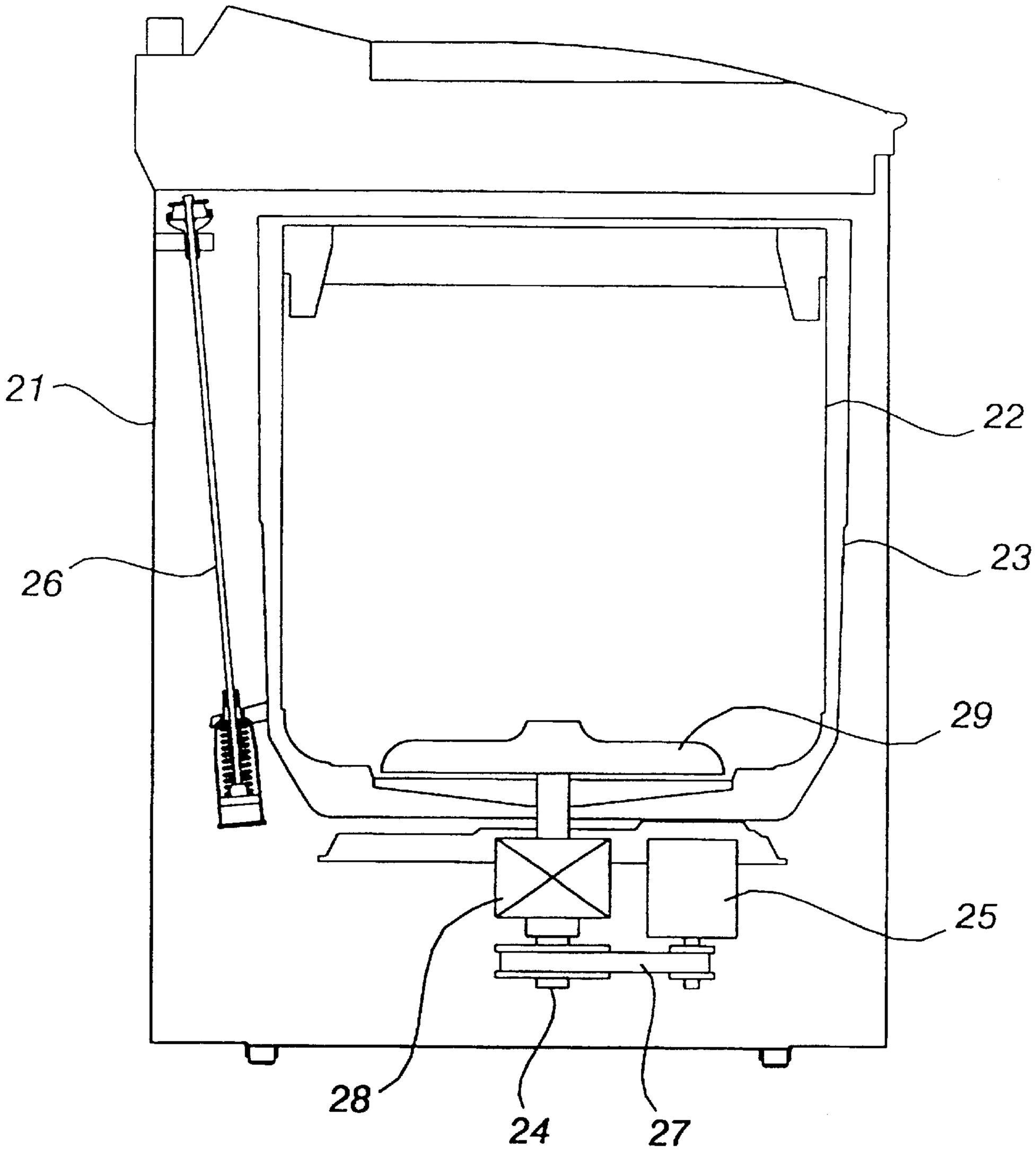


FIG.3(Prior Art)

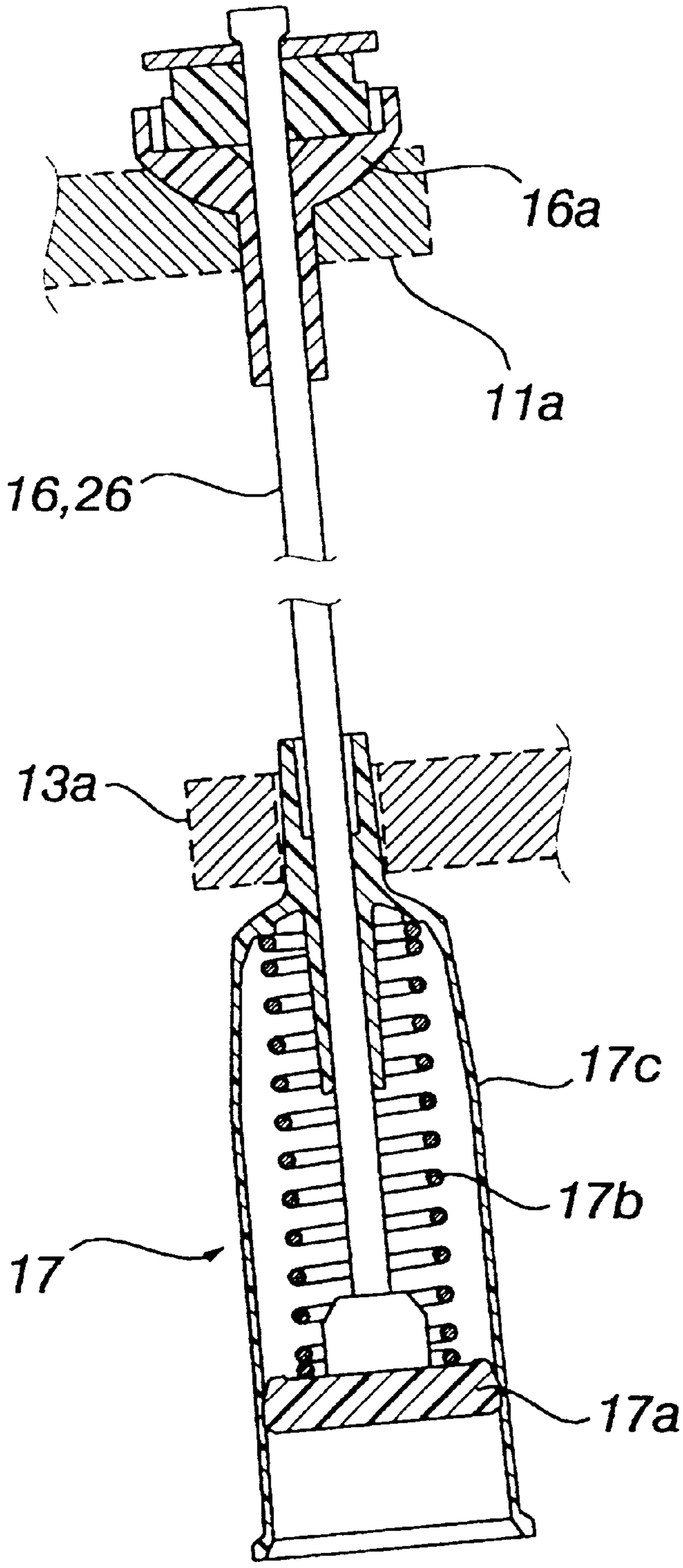


FIG.4

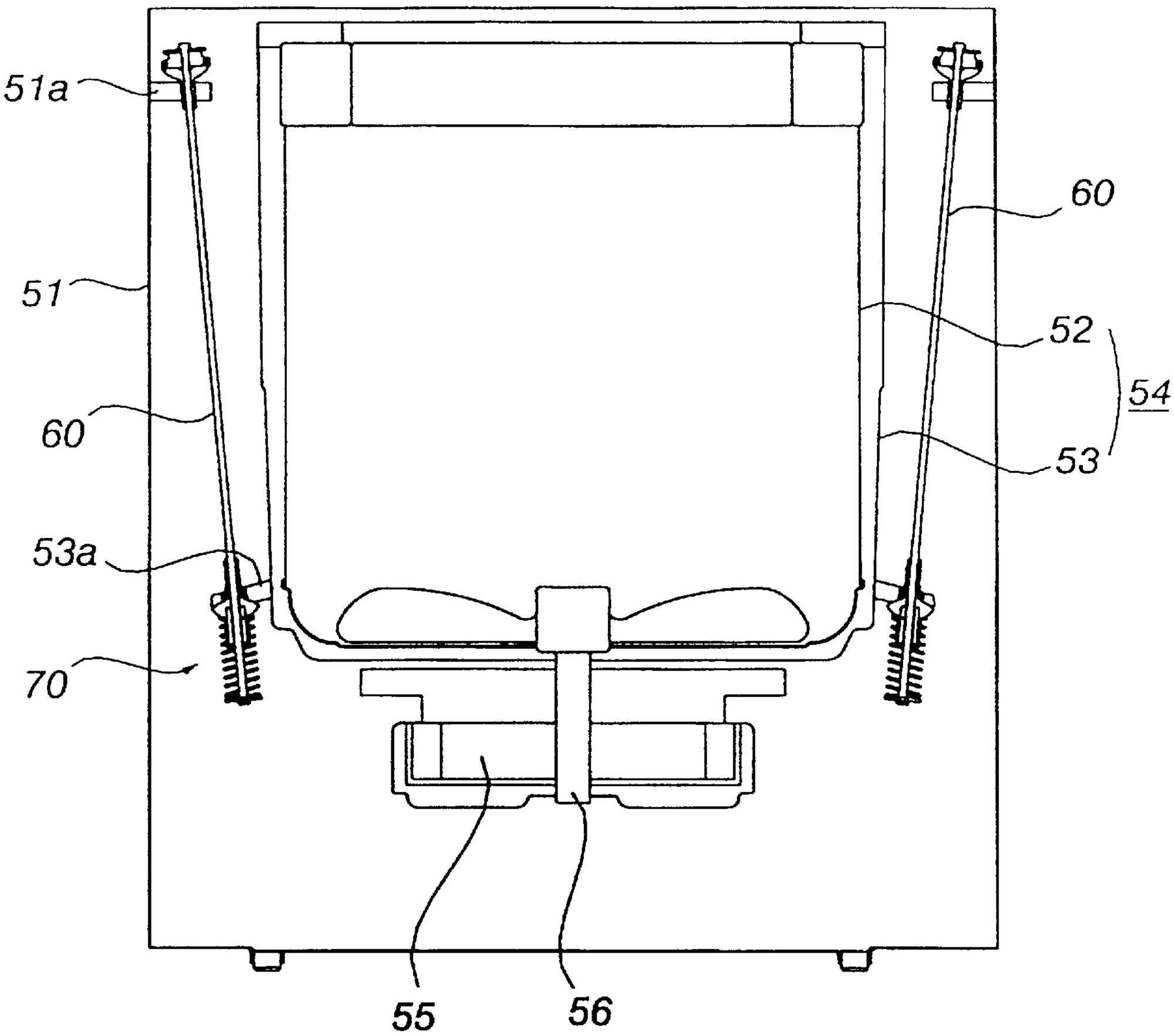


FIG.5

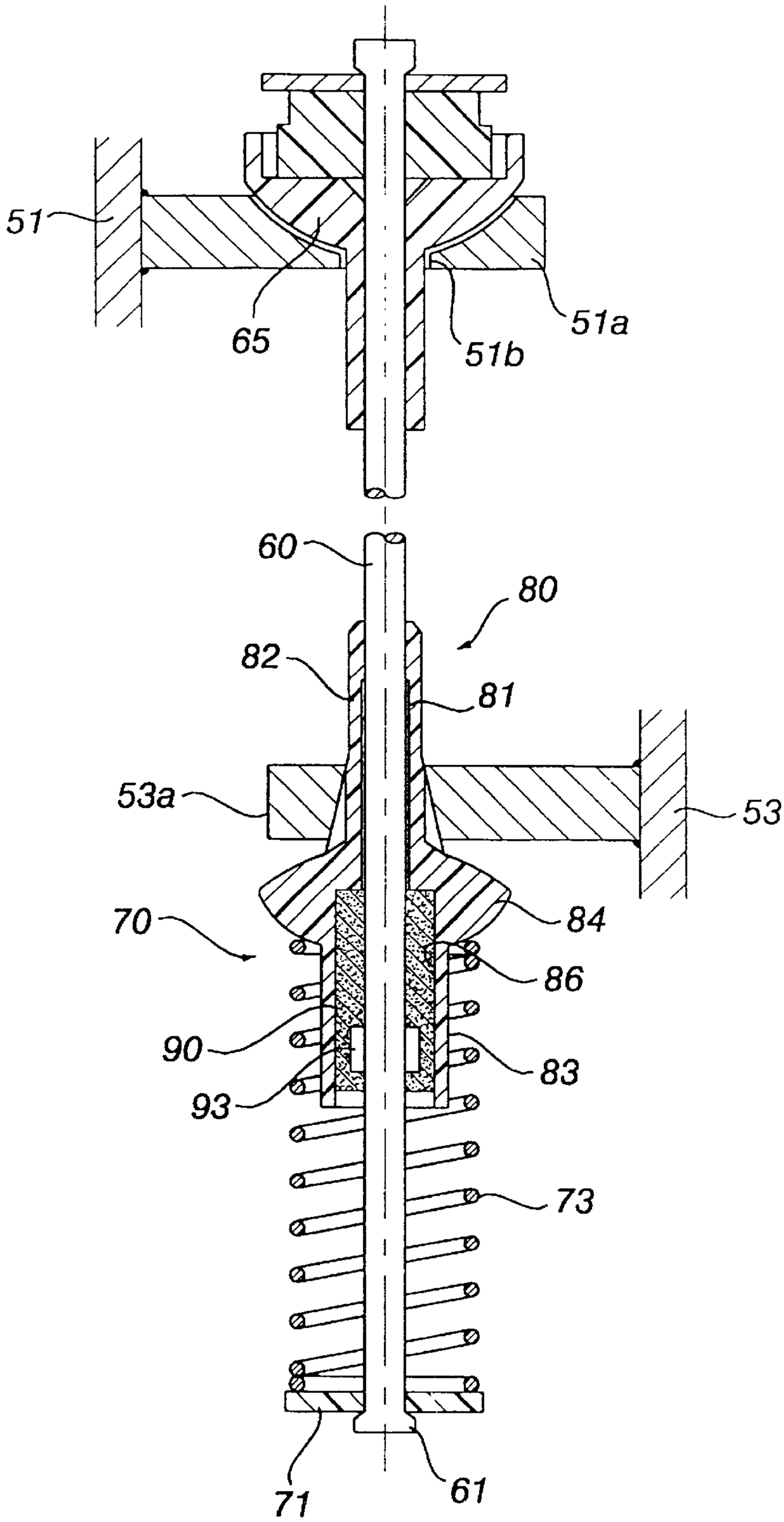


FIG.6A

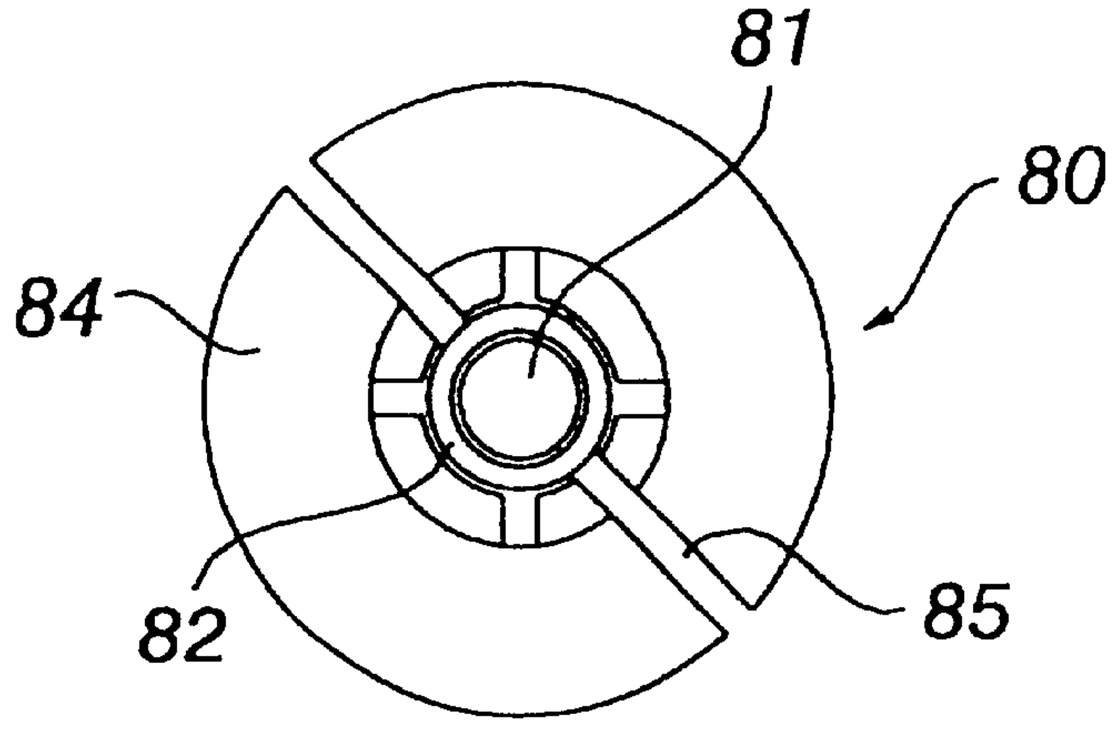


FIG.6B

FIG.6C

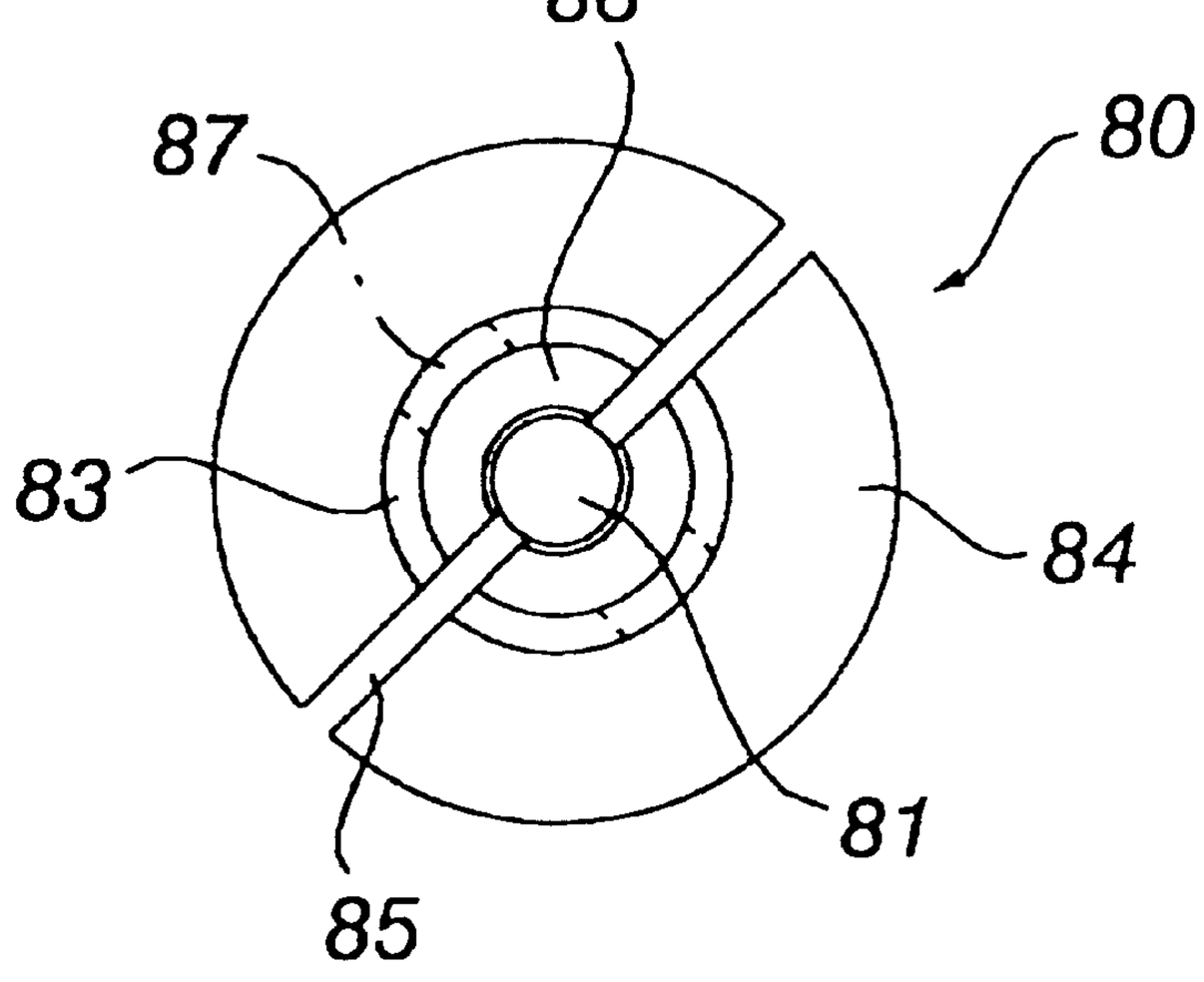


FIG.7A

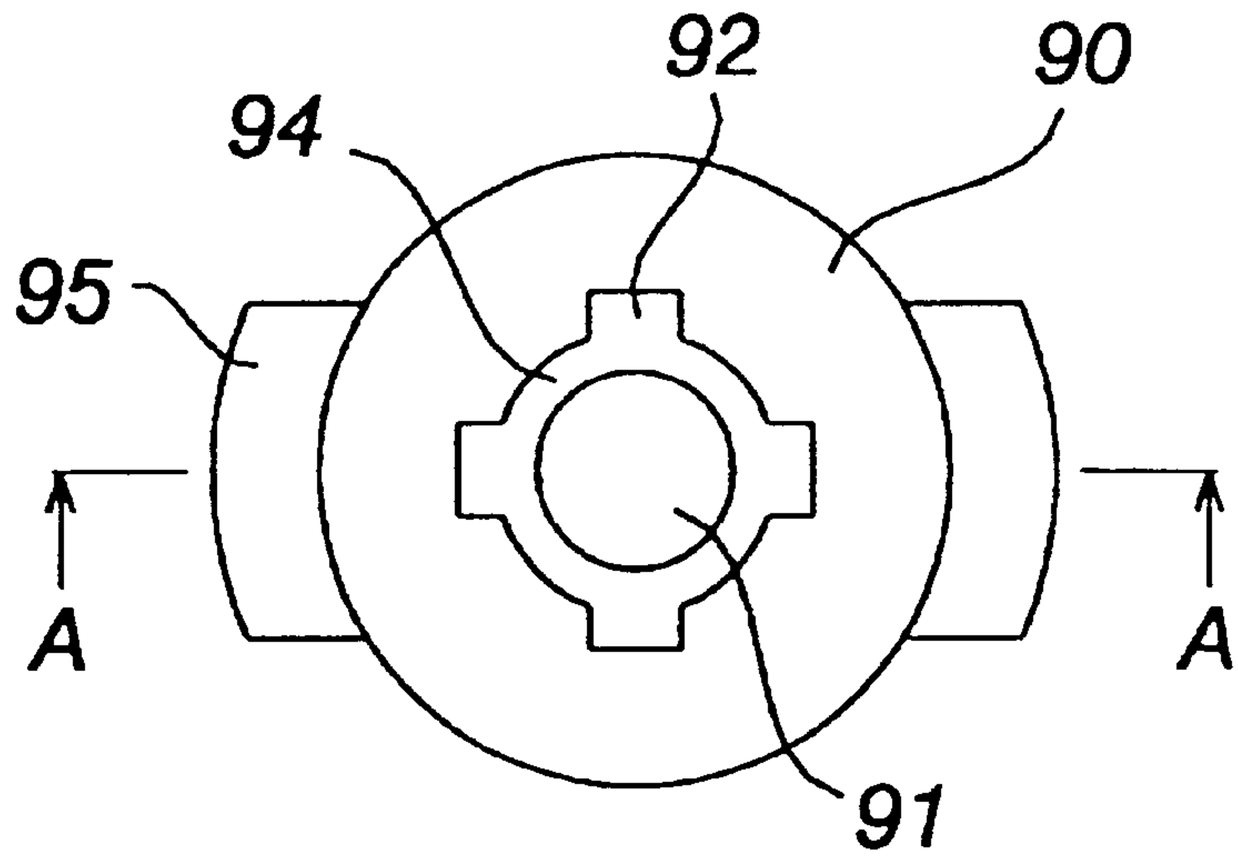


FIG.7B

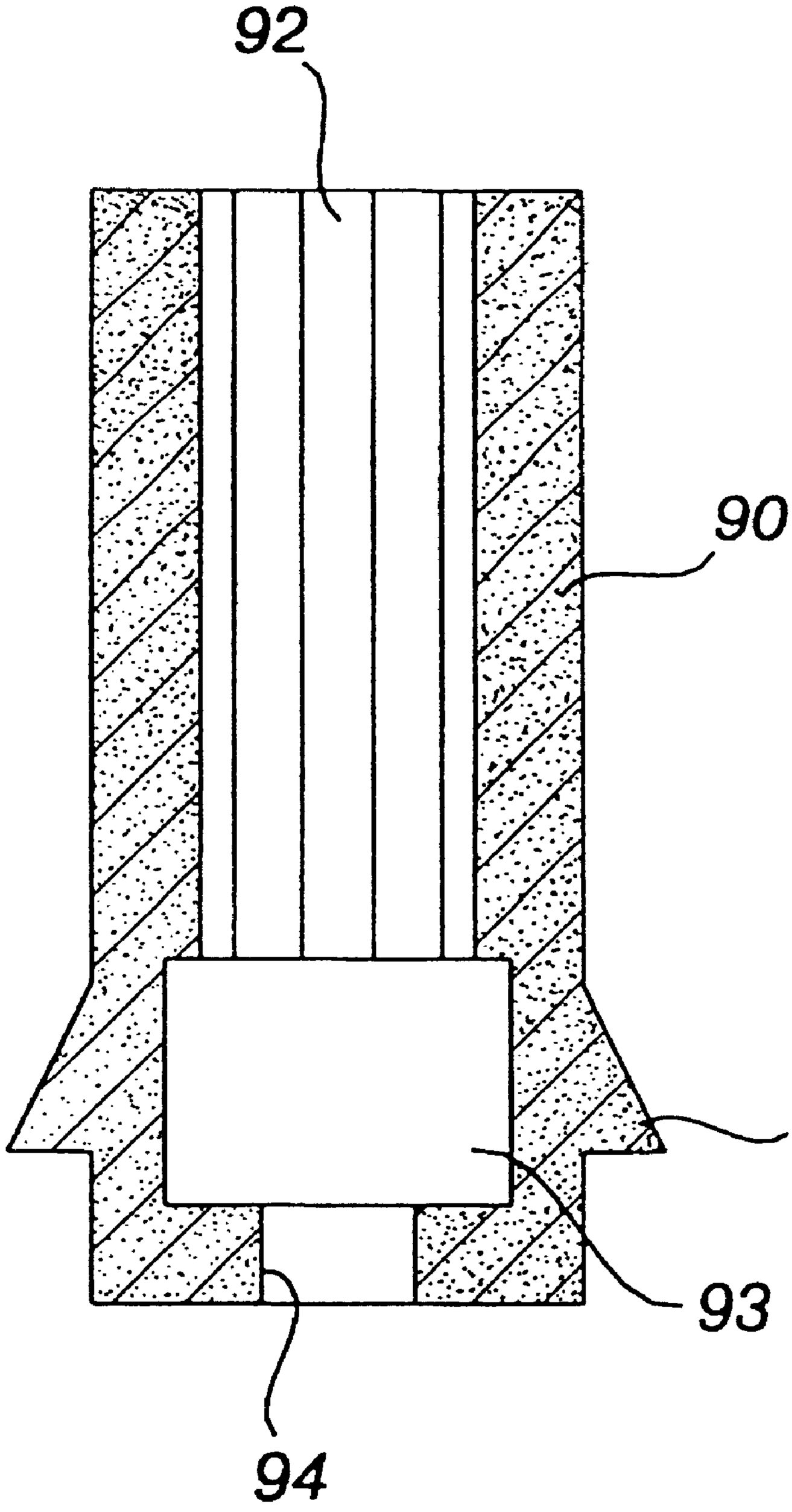
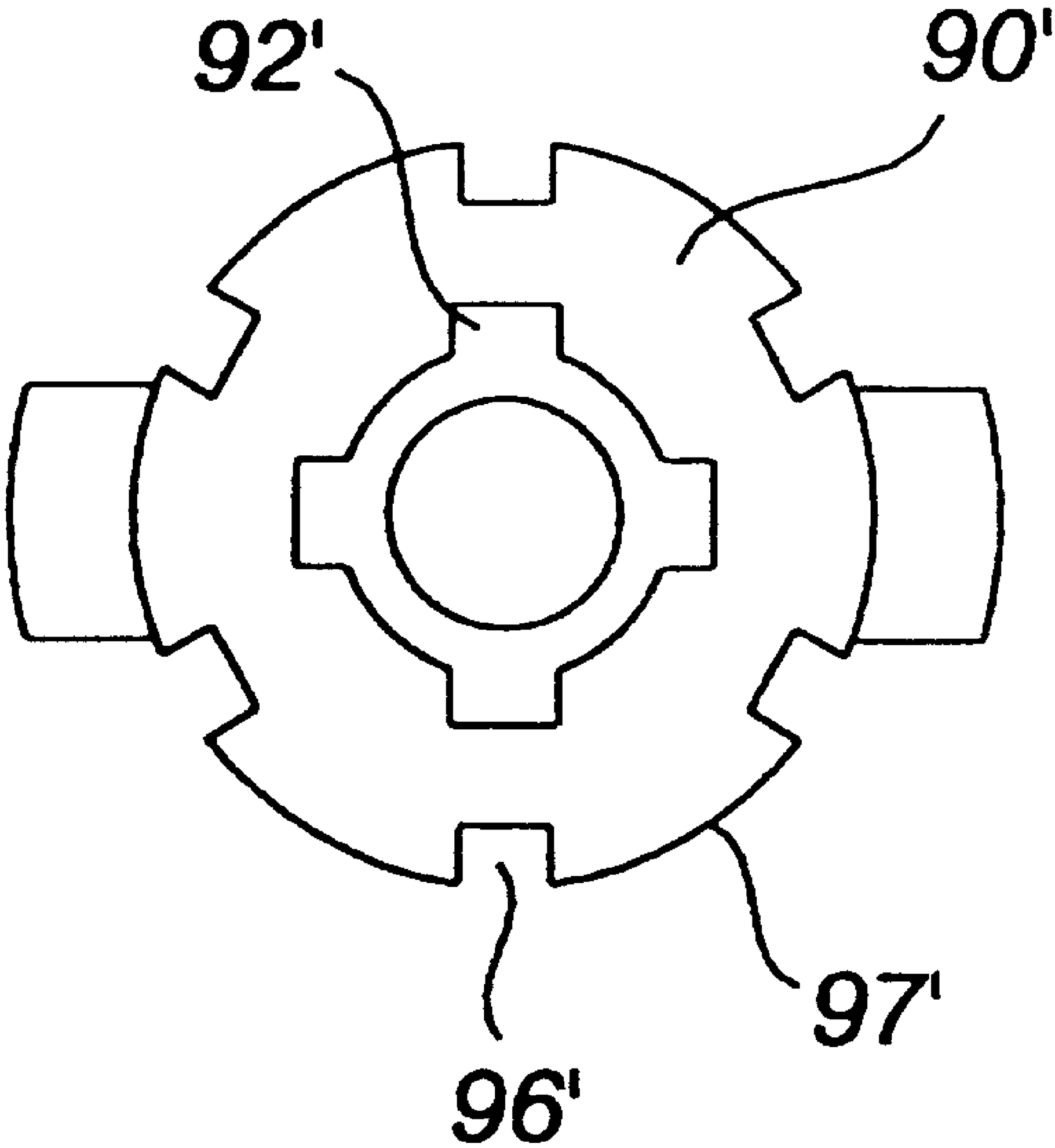


FIG.8



SUSPENSION APPARATUS OF WASHING MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a washing machine for washing laundry such as clothes, and more particularly, to a suspension apparatus of a washing machine which makes a washing tub suspended in a casing of the washing machine so as to minimize vibrations and noises generated when the washing machine is operated.

2. Description of the Related Art

In general, automatic washing machines for washing clothes by using agitated water currents may be classified into various types of washing machines depending on the driving system thereof or the type of a pulsator.

FIG. **1** is a vertical sectional view illustrating the internal structure of a conventional directly coupled motor type washing machine, and FIG. **2** is a vertical sectional view illustrating the internal structure of a conventional clutch type washing machine employing a pulsator.

First, the directly coupled motor type washing machine as shown in FIG. **1** is rotationally driven according to the operation of a motor **15** since an inner drum **12** is directly connected to the driving shaft **14** of the motor **15**, a washing tub comprised of the inner drum **12** and an outer drum **13** is suspended by four suspension rods **16** in a casing **11** of the washing machine, and the motor **15** is positioned below the outer drum **13**.

The driving shaft **14** of the motor **15** is connected to the inner drum **12** through the outer drum **13**, and while the inner drum **12** rotates according to the operation of the motor **15**, washing operation is performed.

On the other hand, in the clutch type washing machine, a pulsator **29** attached to the bottom surface of an inner drum **22** is rotated by a driving shaft **24** connected to a motor **25**, and a clutch **28** is provided at the driving shaft **24** so that rotational power transmission can be connected or disconnected.

That is, the motor **25** is provided below an outer drum **23** of a washing tub, the motor **25** is connected to the driving shaft **24** via a pulley and a belt **27**, and the clutch **28** is installed in the middle of the driving shaft **24** so that the rotational power transmission can be connected or disconnected.

In addition, while in the directly coupled motor type washing machine the motor directly drives the inner drum, the driving shaft **24** is connected to the pulsator **29** provided in the inner drum **22** as a rotating body, and washing operation is performed as the pulsator **29** is driven to rotate in a state in which the inner drum **22** does not rotate.

The outer drum **23** is connected to a casing **21** of the washing machine by four suspension rods **26** in a suspended manner as in the directly coupled motor type washing machine.

As described above, in both the directly coupled motor type washing machine and the clutch type washing machine, the inner and outer drums in which wash operation is performed are connected in the casing of the washing by the suspension rods as shown in FIG. **3**. Referring to FIGS. **1** and **3**, a suspension member **16***a* is installed at the upper end of the suspension rod **16** or **26** and fitted to a bracket **11***a* of the casing of the washing machine, and a damping force changing means **17** is installed at the lower end of the suspension rod **16** or **26** and performs damping function during the operation of the washing machine while supporting a bracket **13***a* of the outer drum.

In particular, the damping force changing means **17** is provided with a damper base **17***a* of a flange shape at the lower end of the suspension rod **16** as shown in FIG. **3**, a damper spring **17***b* is disposed on the upper side of the damper base **17***a*, and a damper cap **17***c* which supports the outer drum **13** is capped over the damper spring **17***b*.

Therefore, the load generated from the inner and outer drums is transferred to the damper spring **17***b* via the damper cap **17***c*, and at this time the damper spring **17***b* does buffering function while being supported by the suspension rod **16**.

Since, the distribution of laundry is not symmetrical with respect to the rotating shaft at the early stage of an extraction phase, eccentric load occurs in the washing tub, and accordingly vibrations and noises may be severely generated.

To form a damping force for buffering such vibrations is an important role of the damping force changing means **17**. That is, the damping force converts kinetic energy into thermal energy, etc. to decrease the amplitude of the vibrations, and is, in the damping force changing means **17**, generated by a friction force ++++between the damper base **17***a* and the damper cap **17***c* and the flow of air into or out of the damping force changing means **17**.

However, there is a problem in which when the conventional suspension apparatus employing the suspension rods **16** as described above is designed to have a greater damping force so as to suppress abnormal vibrations due to eccentric load generated at the early stage of an extraction phase, the amplitudes of noises become larger during the normal operation of the washing machine, and when the suspension apparatus is designed to have a lesser damping force so as to decrease the amplitudes of noises generated during the normal operation, excessive vibrations are generated at the early stage of the extraction phase and accordingly walking phenomena of the washing machine may occur.

Consequently, unless a damping force which satisfies the characteristics required during the early stage of the extraction phase and during the normal washing operation is formed, most portions of the vibrational forces generated at the inner and outer drums **12** and **13** are transferred to the casing **11** of the washing machine via the suspension rods **16**, the amplitude of the vibrations of the casing **11** is more increased by the components of the transferred vibrational forces which are near to the resonant frequency of the casing **11**. Therefore, the suspension rods **16** and the outer drum **13** are also vibrated, and accordingly more noises are generated when the washing machine is operated.

SUMMARY OF THE INVENTION

To solve the above problems, it is an objective of the present invention to provide a suspension apparatus of a washing machine which is capable of minimizing vibrations and noises by changing the structure of a damping force changing means so that the damping force of the damping force changing means can vary with acting load generated when the washing machine is operated.

To achieve the above objective, there is provided a suspension apparatus of a washing machine comprising:

suspension rods the upper portions of which are connected to a casing of the washing machine and the lower portions of which are connected to a washing tub so that the washing tub can be supported in the casing in a suspended state;

damper bases installed at the respective lower ends of the suspension rods;

damping force changing means fitted around the respective suspension rods and positioned above the respective damper bases, so as to be compressed according to the variations in load of the washing tub and change the damping force generated when contacting the respective suspension rods; and

elastic means installed between the damping force changing means and the damper bases, respectively, so as to do buffering action, and, in addition, providing compression forces for the damping force changing means, respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objective and advantage of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. **1** is a vertical sectional view illustrating the internal structure of a directly coupled motor type washing machine provided with a conventional suspension apparatus;

FIG. **2** is a vertical sectional view illustrating the internal structure of a clutch type washing machine provided with a conventional suspension apparatus;

FIG. **3** is a vertical sectional view illustrating a conventional suspension apparatus;

FIG. **4** is a vertical sectional view illustrating the internal structure of a washing machine provided with a suspension apparatus according to the present invention;

FIG. **5** is a vertical sectional view illustrating a suspension apparatus according to the present invention;

FIG. **6**A is a plan view illustrating a supporting member which is an essential part of the present invention;

FIG. **6**B is a front view illustrating the supporting member shown FIG. **6**A;

FIG. **6**C is a bottom view illustrating the supporting member shown FIGS. **6**A and **6**B;

FIG. **7**A is a plan view illustrating one embodiment of a friction member which is an essential part of the present invention;

FIG. **7**B is a sectional view taken along line A—A of FIG. **7**A; and

FIG. **8** is a plan view illustrating another embodiment of a friction member of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **4** is a vertical sectional view illustrating the internal structure of a directly coupled motor type washing machine provided with a suspension apparatus according to the present invention.

Referring to FIG. **4**, a washing tub **54** comprised of an inner drum **52** and an outer drum **53** is supported in a suspended state by four suspension rods **60** in a casing **51** of the washing machine. In addition, a motor **55** is installed below the outer drum **53**, and the driving shaft **56** of the motor **55** is connected to the inner drum **52** through the outer drum **53** and can rotate the inner drum **52**.

The suspension rod **60** is formed in an elongated rod shape, and the upper end portion thereof is connected to a bracket **51***a* fixed to an upper portion of the casing **51** of the washing machine and the lower portion thereof is connected to a bracket **53***a* fixed to the outer drum **53**.

Further, a damping force changing means **70** is installed at the lower end of the suspension rod **60**, and as the damping force thereof vary with washing load change, the damping force changing means **70** gives buffering action to the washing tub **54**.

FIG. **5** is a detailed vertical sectional view illustrating the suspension rod **60** and the damping force changing means **70**.

Referring to FIG. **5**, a suspension member **65** is fitted to the upper end portion of the suspension rod **60**, a bracket **51***a* provided with a hole **51***b* is fixed to the casing **51** of the washing machine. The upper portion of the suspension rod **60** is inserted through the bracket **51***a* in a state in which the suspension member **65** of the suspension rod **60** is hung by the hole **51***b*, and the damping force changing means **70** is installed at the lower portion of the suspension rod **60** and is connected to the bracket **53***a* fixed to the outer drum **53**.

A damper base **71** of a wash shape is inserted at the lower end **61** of the suspension rod **60**, and the lower end **61** of the suspension rod **60** is expanded in radial directions so that the damper base **71** cannot escape.

A damper spring **73** fitted around the suspension rod **60** is disposed on the damper base **71**, and a supporting member **80** is disposed on the damper spring **73**.

A hole **81** is formed through the center portion of the supporting member **80**, and the supporting member **80** is fitted around the suspension rod **60** disposed between the bracket **53***a* of the outer drum **53** and the damper spring **73** so as to be movalble along the suspension rod **60** and supports the washing tub **54** by supporting the bracket **53***a*.

A friction member **90** is installed in a bore **86** of the supporting member **80** so that the friction member **90** can generate a friction force while contacting the suspension rod **60**.

The supporting member **80** and the friction member **90** as described above are installed so that the friction force due to the contact with the suspension rod **60** can vary with change in vertical load generated between the outer drum **53** and the damper spring **73** during the operation of the washing machine.

FIGS. **6**A, **6**B and **6**C are detailed plan, front and bottom views illustrating the supporting member **80**.

Referring to FIGS. **6**A, **6**B and **6**C, the supporting member **80** is formed with a bracket-fitted portion **82**, a slopingly surfaced portion **84**, and a spring-fitted portion **83**.

The bracket-fitted portion **82** and the spring-fitted portion **83** are formed to project in corresponding cylindrical shapes at the upside and downside of the slopingly surfaced portion **84**, and inserted into the bracket **53***a* of the outer drum **53** and the damper spring **73**, respectively.

In the supporting member **80**, a cutout portion **85** is formed from the lower end of the spring-fitted portion **83** to a predetermined height of the bracket-fitted portion **82**, and a bore **86** is formed in the slopingly surfaced portion **84** and the spring-fitted portion **83** so that the friction member **90** can be inserted into the bore **86** as shown in FIG. **5**.

The slopingly surfaced portion **84** is projected in radial directions, and serves to convert a vertical compressional force between the bracket **53***a* of the outer drum **53** and the damper spring **73** into a horizontal compressional force.

Since the upper and lower surfaces of the slopingly surfaced portion **84** are formed with sloping surfaces and the thickness of the slopingly surfaced portion **84** becomes gradually thicker from the outer portion to the center portion thereof, the slopingly surfaced portion **84** can be contracted

inward due to the cutout portion **85** when a compressional force is provided by the damper spring **73**.

FIG. **7**A is a plan view illustrating the friction member **90** which is inserted into the bore **86** of the supporting member **80** as described above, and FIG. **7**B is a sectional view taken along line A—A of FIG. **7**A.

Referring FIGS. **7**A and **7**B, it is preferable that the friction member **90** is formed in a cylindrical shape so as to be installed between the suspension rod **60** and the supporting member **80**, and is made of a rubber material which is easily deformed by a compressional force and easily creates a friction force.

In addition, it is preferable that a lubricant is injected to the inner surface of the friction member **90**. Since when the lubricant is not injected thereto, it is difficult to effectively cause variation in a damping force to occur according to the increase or decrease of washing load due to excessive dry friction force which may occur between the friction member **90** and the suspension rod **60**, it is preferable to form a proper friction force by injecting a lubricant such as grease to the inner surface of the friction member **90**.

A plurality of guide grooves **92** are vertically formed at the surface of a hole **91** formed in the friction member **90** so that the lubricant can be smoothly supplied to the hole **91**. Of course, it is preferable that the guide grooves **92** are symmetrically disposed so that the friction member **90** can form a balanced friction force when contacting the suspension rod **60**.

A lubricant storing recess **93** is formed at the lower portion of the hole **91** in a circumferential direction so that the lubricant can be contained therein, and an O-ring portion **94** which serves as an O-ring is formed below the lubricant storing recess **93** by forming the inner diameter thereof to be relatively small so that the lubricant cannot leak.

As long as an inwardly compressing force is continuously maintained at the supporting member **80** by the bracket **53***a* of the outer drum **53** and damper spring **73** even though as the friction member **90** contacts the suspending rod **60**, the contacting surface thereof is abraded to some extent, the friction member **90** can continue to form a friction force.

In addition as shown in FIGS. **6**B, **6**C, **7**A and **7**B, two projections **95** are formed at outer sides of the friction member **90** so that the friction forming member **90** can be easily fitted into the inside of the supporting member **80**, and fitting holes **87** are formed at the supporting member **80** so that the projections **95** can be fitted into the corresponding fitting holes **87**.

FIG. **8** shows a plan view illustrating another embodiment of a friction member.

Referring to FIG. **8**, in the case of a friction member **90'** of another embodiment, an elongated grooves **96'** are vertically formed in the same direction as the inner guide grooves **92'** at the outer surface of the friction member **90'** so that when an inwardly acting compression force is applied to the friction member **90'** via the supporting member **80**, the friction member **90'** can be more easily deformed and a proper friction force can be generated.

Therefore, since the compression force of the supporting member **80** is concentrated on the projected surfaces **97'** at which the elongated grooves **96'** of the friction member **90'** are not formed, the friction member **90'** can be easily deformed and the friction force between the friction member **90'** and the suspension rod **60** can be formed.

The operation of the suspension apparatus of a washing machine configured as above according to the present invention will be described as follows.

When the washing machine is operated the washing phase is proceeded as the laundry is agitated by water currents generated in the inner drum **52**, and after the washing and rinsing phases, the extraction phase is carried out as the inner drum **52** at high speed.

When the washing machine is in the washing phase or extraction phase, load variations occur due to the movement of the laundry and water therein, and in particular severely eccentric load occurs at the early stage of the extraction phase.

When such severely eccentric load occurs instantaneously, the change of the load is transferred to the damper spring **73** via the outer drum **53** and the supporting member **80**, and, at this time, since the supporting member **80** is subject to a compression force between the bracket **53***a* of the outer drum **53** and the damper spring **73**, the cutout portion **85** is narrowed and the friction member **90** therein is compressed.

Therefore, since the friction force between the one side friction member **90** and the suspension rod **60** among the four suspension rods **60** supporting the outer drum **53** is increased, and the friction force on the other side friction members **90** and the suspension rods **60** is maintained in a normal state, severe vibrations generated when the outer drum **53** rotates in unbalanced states due to the eccentric load can be minimized.

As described above, the damping force changing means of the present invention can change frictional damping force according to the variation of load and increases the damping force thereof so as to correspond to the inertia of the load when the inertia is large, and therefore the damping force changing means can effectively respond to instantaneous variation of load which occurs during the operation of the washing machine and the generation of vibrations and noises can be suppressed.

The above-described suspension apparatus of a washing machine of the present invention can minimize the generation of vibrations by changing the damping force thereof when eccentric load occurs at the early stage of the extraction phase, and, in addition, can ideally damp the variations in load transferred to the casing of the washing machine via the suspension rods during the normal operation of the washing machine. Therefore, the suspension apparatus provides an advantage in which the generation of noises can be effectively suppressed.

In addition, since, in the suspension apparatus of the present invention, a compression force is maintained by the supporting member even though the friction surfaces between the friction members and the suspension rods are abraded due to the use of the suspension apparatus for a long time, the decrease in a damping force due to the abrasion of the friction surfaces as in the conventional art can be prevented, and the suspension apparatus of the present invention provides an advantage in which excellent damping performance can be maintained for a long time.

The suspension apparatus of the present invention can be adapted in not only the directly coupled motor type washing machine but also all the other types of washing machine.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been changed in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A suspension apparatus of a washing machine comprising:

suspension rods the upper portions of which are connected to a casing of the washing machine and the lower portions of which are connected to a washing tub so that the washing tub can be supported in the casing in a suspended state;

damper bases installed at the respective lower ends of the suspension rods;

damping force changing means fitted around the respective suspension rods to be movable along the respective suspension rods and positioned above the respective damper bases, so as to be compressed according to the variations in load of the washing tub and change the damping force; and

elastic means installed between the damping force changing means and the damper bases, respectively, so as to do buffering action, and, in addition, providing compression forces for the damping force changing means, respectively;

wherein each of the damping force changing means includes a supporting member which has a center hole so as to be fitted around the suspension rod, supports a bracket fixed to the washing tub and is deformed in the inward or outward direction by the compression force provided by the washing tub and the elastic means; and a friction member which is installed in the supporting member and changes the friction force between the friction member and the suspension rod according to the deformation of the supporting member in the inward or outward direction;

wherein the supporting member includes a slopingly surfaced portion and a cutout portion, the slopingly surfaced portion is located between the bracket of the washing tub and the elastic means and is slopingly projected so that when a vertical compression force acts on the supporting member, the supporting member can be deformed in the inward or outward direction, and the cutout portion is formed from the lower end of the supporting portion and to a predetermined height;

wherein the supporting member is formed with the slopingly surfaced portion radially projected, a bracket-fitted portion formed to project in a cylindrical shape at the upside of the slopingly surfaced portion and inserted into the bracket of the washing tub, and a spring-fitted portion which is formed to project in a cylindrical shape at the downside of the slopingly surfaced portion and around which the elastic biasing means is fitted.

2. The suspension apparatus of a washing machine as claimed in claim **1**, wherein a frictional-material-inserted portion having a cylindrical bore is formed at the insides of the slopingly surfaced portion and the spring-fitted portion of the supporting member so that the friction member can be inserted into the frictional-material-inserted portion.

3. A suspension apparatus of a washing machine comprising:

suspension rods the upper portions of which are connected to a casing of the washing machine and the lower portions of which are connected to a washing tub so that the washing tub can be supported in the casing in a suspended state;

damper bases installed at the respective lower ends of the suspension rods;

damping force changing means fitted around the respective suspension rods to be movable along the respective suspension rods and positioned above the respective damper bases, so as to be compressed according to the variations in load of the washing tub and change the damping force; and

elastic means installed between the damping force changing means and the damper bases, respectively, so as to do buffering action, and, in addition, providing compression forces for the damping force changing means, respectively;

wherein each of the damping force changing means includes a supporting member which has a center hole so as to be fitted around the suspension rod, supports a bracket fixed to the washing tub and is deformed in the inward or outward direction by the compression force provided by the washing tub and the elastic means; and a friction member which is installed in the supporting member and changes the friction force between the friction member and the suspension rod according to the deformation of the supporting member in the inward or outward direction;

wherein the friction member is in a cylindrical shape and is made of rubber, a plurality of guide grooves are vertically formed at the inner surface of the center hole, and a lubricant storing recess is formed at the lower portion of the center hole in a circumferential direction so that injected lubricant can be contained therein.

4. The suspension apparatus of a washing machine as claimed in claim **3**, wherein an O-ring portion is formed below the lubricant storing recess by forming the inner diameter thereof to be relatively small so that the lubricant cannot leak.

5. The suspension apparatus of a washing machine as claimed in claim **3**, wherein a plurality of projections are formed at the outer surface of the friction member.

6. The suspension apparatus of a washing machine as claimed in claim **3**, wherein a plurality of grooves are vertically formed at the outer surface of the friction member.

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